SYSTEMS AND METHODS FOR WIRELESSLY COUPLING A WEARABLE COMPUTING DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application No. 62/740,708, filed 3 Oct. 2018, and U.S. Provisional Application No. 62/741,099, filed 4 Oct. 2018, the contents of which are incorporated herein in their entirety by reference.

TECHNICAL FIELD

The present systems, devices, and methods generally relate to network communications in wearable computing devices.

BACKGROUND

Electronic devices are commonplace throughout most of the world today. Advancements in integrated circuit technology have enabled the development of electronic devices that are sufficiently small and lightweight to be carried by the user. Such "portable" electronic devices may include on-board power supplies (such as batteries or other power storage systems) and may be "wireless" (i.e., designed to operate without any wire-connections to other, non-portable electronic systems); however, a small and lightweight electronic device may still be considered portable even if it includes a wire-connection to a non-portable electronic system. For example, a microphone may be considered a portable electronic device whether it is operated wirelessly or through a wire-connection.

The convenience afforded by the portability of electronic devices has fostered a huge industry. Smartphones, audio players, laptop computers, tablet computers, and e-book readers are all examples of portable electronic devices. However, the convenience of being able to carry a portable electronic device has also introduced the inconvenience of encumbering the user's hands with the device itself. This problem is addressed by making an electronic device not only portable, but wearable.

A wearable electronic device is any portable electronic device that a user can carry without physically grasping, clutching, or otherwise holding onto the device with their hands. For example, a wearable electronic device may be attached or coupled to the user by a strap or straps, a band or bands, a clip or clips, an adhesive, a pin and clasp, an article of clothing, tension or elastic support, an interference fit, an ergonomic form, etc. Examples of wearable electronic devices include digital wristwatches, electronic armbands, electronic rings, electronic ankle-bracelets or "anklets," head-mounted electronic display units, hearing aids, and so on.

Because they are worn on the body of the user, visible to others, and generally present for long periods of time, form factor (i.e., size, geometry, and appearance) is a major design consideration in wearable electronic devices.

BRIEF SUMMARY

A method of wirelessly communicatively coupling a wearable computing device to a host computing device may be summarized as including: the host computing device receiving an advertisement packet via a low-power personal

area network; in response to the advertisement packet, transmitting a connection request via the low-power personal area network; pairing via the low-power personal area network; transmitting a data message when pairing via the low-power personal area network, the data message comprising an instruction to pair via a general personal area network; and pairing via the general personal area network.

The method may further include, prior to receiving the advertisement packet, the host computing device entering into a listening mode.

Pairing via the low-power personal area network may further include receiving a connection request confirmation from the wearable computing device, and validating the connection request confirmation.

The method may further include, prior to pairing via the general personal area network, receiving a service discovery request from the wearable computing device, and transmitting a services list to the wearable computing device in response to the service discovery request.

The method may further include: receiving a notification registration request from the wearable computing device; in response to the notification registration request, notifying the wearable computing device of one or more characteristics; receiving a characteristic write request; and in response to the characteristic write request, pre-authorizing the wearable computing device for the pairing via the general personal area network.

The method may further include providing the data message in the form of a notification message.

The method may further include using a low bandwidth personal area network for the low-power personal area network.

The method may further include using a Bluetooth Low Energy network for the low bandwidth wireless personal area network.

The method may further include using the general personal area network to provide greater bandwidth than the low-power personal area network.

The method may further include using a Bluetooth personal area network for the general personal area network.

In some cases, pairing via the general personal area network includes a first stage pairing and a second stage pairing. The first stage pairing may include performing a bonding key exchange with the wearable computing device to obtain at least one bonding key. The method may further include using the at least one bonding key during the second stage pairing. The method may further include providing the notification message in the form of an Apple Notification Center Service message.

A non-transitory computer readable medium may be summarized as storing computer-executable instructions which, when executed by a computer processor, cause the computer processor to carry out the methods as described herein.

A host computing device for managing communications with a wearable computing device may be summarized as including: a memory; a personal area networking interface configured to communicatively couple the host computing device to a low-power personal area network and a general personal area network; a processor operatively coupled to the memory and the personal area networking interface; the processor configured to: receive an advertisement packet from the wearable computing device via the low-power personal area network; in response to the advertisement packet, transmit a connection request via the low-power personal area network; pair with the wearable computing device via the low-power personal area network; transmit a